

WHAT IS CLAIMED IS:

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1 1. A computer implemented method of approximating a gray
2 scale tone with a more limited range image producer,
3 comprising the steps of:
4 associating one of a plurality of tone curves with each
5 pixel of a screening matrix;
6 generating polynomial coefficients of a curve
7 approximating each of said plurality of tone curves;
8 storing said polynomial coefficients approximating each
9 of said plurality of tone curves in a look-up table;
10 mapping each pixel of an image to a corresponding pixel
11 of said screening matrix;
12 for each pixel of said image
13 recalling said polynomial coefficients
14 approximating said tone curve associated with said pixel
15 of said screening matrix mapped to said pixel, and
16 computing a pixel output value from a pixel input
17 value of said pixel and said recalled polynomial
18 coefficients.

1 2. The computer implemented method of claim 1, wherein:
2 said polynomial is a third degree polynomial of the form
3

4
$$y = ((a * x + b) * x + c) * x$$

5

6 where: y is the pixel output value to be computer; a is a
7 first coefficient; b is a second coefficient; c is a third
8 coefficient; and x is the pixel input value.

1 3. The computer implemented method of claim 2, wherein:
2 said step of computing a pixel output value includes
3 multiplying said pixel input value by said first
4 coefficient producing a first intermediate value,
5 adding said second coefficient to said first
6 intermediate value producing a second intermediate value,
7 multiplying said second intermediate value by said
8 pixel input value producing a third intermediate value,
9 adding said third coefficient to said third
10 intermediate value producing a fourth intermediate value,
11 and
12 multiplying said fourth intermediate value by said
13 pixel input value producing said pixel output value.

1 4. The computer implemented method of claim 2, wherein:
2 said step of computing a pixel output value computes a
3 first pixel output value and a second pixel output value by
4 sequentially
5 (1) multiplying a first pixel input value by a
6 first coefficient corresponding to said first pixel
7 producing a first intermediate value,
8 (2) simultaneously multiplying a second pixel input
9 value by a first coefficient corresponding to said second
10 pixel producing a second intermediate value, and adding
11 a second coefficient corresponding to said first pixel to
12 said first intermediate value producing a third
13 intermediate value,
14 (3) simultaneously multiplying said third
15 intermediate value by said first pixel input value
16 producing a fourth intermediate value, and adding a

17 second coefficient corresponding to said second pixel to
18 said second intermediate value producing a fifth
19 intermediate value,

20 (4) simultaneously multiplying said fifth
21 intermediate value by said second pixel input value
22 producing a sixth intermediate value, and adding said
23 third coefficient corresponding to said first pixel to
24 said fourth intermediate value producing a seventh
25 intermediate value,

26 (5) simultaneously multiplying said seventh
27 intermediate value by said first pixel input value
28 producing said first pixel output value, and adding said
29 third coefficient corresponding to said second pixel to
30 said sixth intermediate value producing an eighth
31 intermediate value, and

32 (6) multiplying said eighth intermediate value by
33 said second pixel input value producing said second pixel
34 output value.

1 5. The computer implemented method of claim 4, wherein:
2 said pixel input values are represented in a fixed point
3 representation of 8 bits including zero integer bits and eight
4 fractional bits;

5 said first, second and third coefficients corresponding
6 to each tone curve are represented in a fixed point
7 representation of 16 bits including four integer bits and
8 twelve fractional bits;

9 said step of adding said second coefficient corresponding
10 to said first pixel to said first intermediate value producing

11 a third intermediate value includes right shifting said first
12 intermediate value 8 bits prior to addition;

13 said step of adding said second coefficient corresponding
14 to said second pixel to said second intermediate value
15 producing a fifth intermediate value includes right shifting
16 said second intermediate value by 8 bits prior to addition;

17 said step of adding said third coefficient corresponding
18 to said first pixel to said fourth intermediate value
19 producing a seventh intermediate value includes right shifting
20 said fourth intermediate value by 8 bits prior to addition;
21 and

22 said step of adding said third coefficient corresponding
23 to said second pixel to said sixth intermediate value
24 producing an eighth intermediate value includes right shifting
25 said sixth intermediate value by 8 bits prior to addition.

1 6. A printer comprising:
2 a transceiver adapted for bidirectional communication
3 with a communications channel;
4 a memory;
5 a print engine adapted for placing color dots on a
6 printed page according to received image data and control
7 signals; and
8 a programmable data processor connected to said
9 transceiver, said memory and said print engine, said
10 programmable data processor programmed to:
11 receive print data corresponding to pages to be
12 printed from the communications channel via said
13 transceiver;

12/30/99

14 convert said print data into image data and control
15 signals for supply to said print engine for printing a
16 corresponding page, said conversion including
17 approximating a gray scale tone with a more limited range
18 print engine by
19 storing polynomial coefficients approximating
20 each of a plurality of tone curves in a look-up
21 table,
22 mapping each pixel of an image to a
23 corresponding pixel of a screening matrix;
24 for each pixel of said image
25 recalling a corresponding set of
26 polynomial coefficients approximating a tone
27 curve associated with said pixel of said
28 screening matrix mapped to said pixel, and
29 computing a pixel output value from a
30 pixel input value of said pixel and said
31 recalled polynomial coefficients.

1 7. The printer of claim 6, wherein:
2 said programmable data processor including a hardware
3 multiplier and an arithmetic logic unit, said programmable
4 data processor being further programmed to compute said pixel
5 output value by
6 multiplying said pixel input value by said first
7 coefficient in said hardware multiplier producing a first
8 intermediate value,
9 adding said second coefficient to said first
10 intermediate value in said arithmetic logic unit
11 producing a second intermediate value,

12 multiplying said second intermediate value by said
13 pixel input value in said hardware multiplier producing
14 a third intermediate value,
15 adding said third coefficient to said third
16 intermediate value in said arithmetic logic unit
17 producing a fourth intermediate value, and
18 multiplying said fourth intermediate value by said
19 pixel input value in said hardware multiplier producing
20 said pixel output value.

1 8. The printer of claim 6, wherein:
2 said programmable data processor including a hardware
3 multiplier and an arithmetic logic unit, said programmable
4 data processor being further programmed to compute said pixel
5 output value by
6 (1) multiplying a first pixel input value by a
7 first coefficient corresponding to said first pixel in
8 said hardware multiplier producing a first intermediate
9 value,
10 (2) simultaneously multiplying a second pixel input
11 value by a first coefficient corresponding to said second
12 pixel in said hardware multiplier producing a second
13 intermediate value, and adding a second coefficient
14 corresponding to said first pixel to said first
15 intermediate value in said arithmetic logic unit
16 producing a third intermediate value,
17 (3) simultaneously multiplying said third
18 intermediate value by said first pixel input value in
19 said hardware multiplier producing a fourth intermediate
20 value, and adding a second coefficient corresponding to

21 said second pixel to said second intermediate value in
22 said arithmetic logic unit producing a fifth intermediate
23 value,

24 (4) simultaneously multiplying said fifth
25 intermediate value by said second pixel input value in
26 said hardware multiplier producing a sixth intermediate
27 value, and adding said third coefficient corresponding to
28 said first pixel to said fourth intermediate value in
29 said arithmetic logic unit producing a seventh
30 intermediate value,

31 (5) simultaneously multiplying said seventh
32 intermediate value by said first pixel input value in
33 said hardware multiplier producing said first pixel
34 output value, and adding said third coefficient
35 corresponding to said second pixel to said sixth
36 intermediate value in said arithmetic logic unit
37 producing an eighth intermediate value, and

38 (6) multiplying said eighth intermediate value by
39 said second pixel input value in said hardware multiplier
40 producing said second pixel output value.

1 9. The printer of claim 8, wherein:

2 said programmable data processor further including a
3 shifter at one input to said arithmetic logic unit, said
4 programmable data processor being further programmed to
5 compute said pixel output value by

6 right shifting said first intermediate value 8 bits
7 prior to addition;

8 right shifting said second intermediate value by 8
9 bits prior to addition;

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